HYDROCARBONS AND AQUEOUS FLUIDS IN CRETACEOUS SEDIMENTS OF THE ICDP-CHICXULUB DRILL CORE YAX-1. V. Lüders[1], B. Horsfield[1], T. Kenkmann[2], B. Mingram[1], A. Wittmann[2]. [1]GeoForschungsZentrum Potsdam, Germany, volue@gfz-potsdam.de, [2]Institut für Mineralogie, Museum für Naturkunde, Humboldt-Universität zu Berlin, Germany

Introduction: The ICDP-Chicxulub drill core Yaxcopoil-1 (*Yax-1*) penetrated through 600 m of carbonate and sulfate sediments which have very probably a Cretaceous age. The sequence, in particular the interval at 1300-1510 m, contain numerous layers rich in organic matter. Fissures and fault zones show alteration parageneses with trapped fluid inclusions.

Organic matter occurrence: Black and dark brownish layers as well as dark coatings around anhydrite nodules are enriched in organic matter. The fine grained mineral paragenesis within these zones consists of potassium feldspar, dolomite, pyrite, marcasite and apatite. These minerals are embedded in a dense organic-rich groundmass (Fig. 1b). The thicker layers with a high amount of organic matter display ductile flow features indicated by foliation, aligned and stretched minerals and rounded porphyroclasts (Fig. 1a). To develop such ductile shear zones a low viscosity and relatively low strain rates are required. These zones indicate a viscous mobilization of the organic matter.

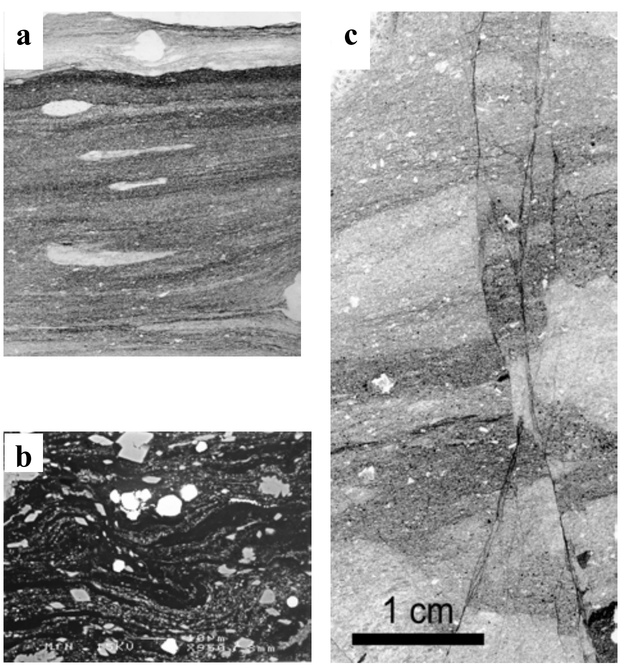

Fig.1(a) Porphyroclasts are embedded in a kerogen-bearing matrix. (Yax-1_1401,11 m) (b) Convolute flow features indicate turbulent flow (Yax-1_1394,16 m). (c) Layers rich in organic matter are displaced by impact-related shear zones (Yax-1_1397,76 m)

The organic-rich layers are displaced by brittle shear zones (Fig. 1c) and were offset by clastic dike breccias. The organic matter is in part autochthonous, consisting of kerogen, and in part allochthonous, consisting of petroleum or bitumen. This is reflected in the solubility of the organic matter which varies between 1-100%. Zones containing allochthonous bituminous organic matter is rich in asphaltenes, this being a feature that is frequently observed in carbonate source rocks and their petroleums. The cross cutting relationship clearly indicates that layers rich in kerogen existed prior to the dikes, and, thus prior to the impact. The migration of bitumen and oil can be documented to have occurred after the emplacement of the dikes and may have been accelerated by an impact-induced thermal overprint. Brittle shear zones and dikes were used as pathways and hosts.

$\delta^{18}O$ vs. $\delta^{13}C$ relationships in calcites and limestones: Carbon and oxygen isotopic compositions were determined in carbonates from the Cretaceous sequence and vein calcites. The carbon and oxygen isotopic compositions of host rocks and fissure calcites show only small isotopic variations. For host rock samples, the $\delta^{18}O$ values range between 22.7 and 25.1‰ when normalized to SMOW and the $\delta^{13}C$ values range between 0 and 2.9 ‰ (PDB). The $\delta^{13}C$ and $\delta^{18}O$ values of vein calcite plot into a similar field to that of the host rocks. For individual samples, the variation and between host rock and fissure calcite is max. 1‰ for $\delta^{18}O$ and 0.7‰ for $\delta^{13}C$, respectively. The observed small variations of the $\delta^{18}O$ and $\delta^{13}C$ values indicate the calcite-forming fluids were derived from the host rocks and that calcite in fissures precipitated at low temperatures. The latter point is also supported by fluid inclusion petrography, i.e. the presence of monophase aqueous fluid inclusions in the calcites. Therefore, it can be excluded that calcite precipitation was caused by fluid migration induced by the impact.

Fluid inclusion studies: Calcite from the suevitic breccia rarely host two-phase fluid inclusions. When present, this type only occurs in growth zones at the base to adjacent rock fragments. Two-phase inclusions show irregular forms and sizes up to 20 µm. The vapor bubbles do not occupy more than 3 % of the total volume of the inclusions and therefore point to lowtemperature (probably > 100 °C) trapping conditions. Other growth zones also contain irregular shaped inclusions, but most of them are monophase aqueous inclusions. Fluid inclusions in clear calcite are always monophase aqueous inclusions. They occur in clusters decorating crystal planes and mostly show rounded-elongated forms. The sizes do not exceed 10 µm. Recrystallized calcite lenses and fissure fillings within massive limestone of the Cretaceous sequence also host monophase aqueous inclusions similar in shape and size as those which are abundant in clear calcite from the suevitic breccia.

In contrast, quartz which was found in two fissures at 990.02 m and 1000.53 m about 100 m below the suevitic breccia host totally different kind of fluid inclusions when compared with calcite. Three main types of fluid inclusions can be distinguished: (1) two-phase aqueous fluid inclusions, (2) two-phase aqueous fluid inclusion hosting a (most probably halite) daughter mineral, and (3) polyphase fluid inclusions with a small liquid phase, a vapor bubble and several solids (Fig.2). Laser-Raman spectroscopic analysis revealed that the latter type of inclusions bears higher hydrocarbon (Fig.3). Two-phase fluid inclusions that appear to be of primary origin show high salinities of about 20 wt.% eq. NaCl and homogenisation temperatures of about 270°C, thus indicating that fluid migration and quartz precipitation was most likely induced by a high thermal event, ostensibly the impact. An intriguing possibility is that the hydrocarbons trapped in type 3 inclusions were derived from the cracking of oil.

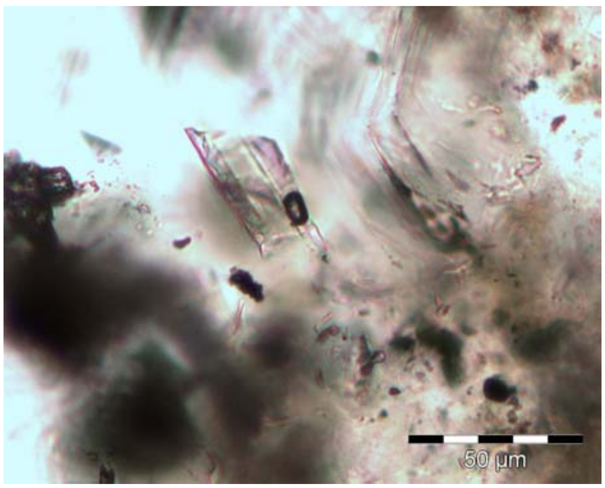

Fig.2 Photomicrograph of a primary type 3 inclusion in quartz at (Yax-1_990.02 m)

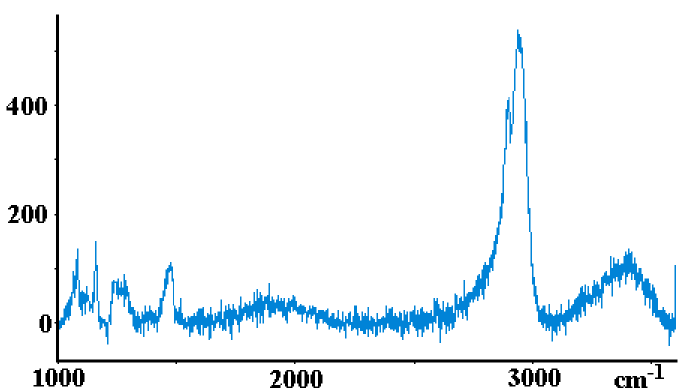

Fig.3 Raman spectrum of the hydrocarbon-bearing gasphase of the primary fluid inclusion shown in Fig.1. The peas at 2894 and 2935 cm^{-1} indicate most probably the presence of ethane and propane in the gas phase.

Acknowledgement: This work is funded by the German Science Foundation (DFG-grant KE732/8)